

# German R&D-intensive industries: Value added and productivity have recovered considerably after the crisis

by Heike Belitz, Martin Gornig und Alexander Schiersch

No large industrialized nation is as strongly specialized in the production of R&D-intensive goods as Germany.<sup>1</sup> In the crisis year 2009 these export-oriented industries had to pass a crucial test. The slump in sales endangered both specialized jobs and the financing of high R&D expenditures, and thus the ability of these industries to compete technologically in the future.

The Commission of Experts for Research and Innovation (Expertenkommission Forschung und Innovation - EFI), which regularly informs the German government about the status and prospects of Germany's technological performance, requires early indications about the development of R&D-intensive industries. Detailed comparative international data regarding industrial development, such as the EU KLEMS Datenbasis and the OECD STAN data, is only available with a lag of two to three years. This is why the DIW has estimated the value added and the volume of labour input for R&D-intensive industries in Germany, the US, Japan, France and the UK for the period from 2008 to 2010 (Box 1). This extended database is used to analyze the development of production and labour productivity up to the present.<sup>2</sup>

Traditionally strong specialization of Germany on R&D-intensive industrial goods

The long-term development of structural differences and specialization patterns in the industries of different countries and regions can be measured based on their relative share on value added. This is the contribution of an industry to the nominal value added in a country, compared to the same ratio calculated using all countries in the analysis, which are here Germany, the US, Japan and the EU-25 (relative share of value added or RVA).<sup>3</sup> When comparing Germany to other European countries, a distinction is made between the EU-14 (members of the EU before 2004 with the exception of Germany) and the EU-10 (members joining in 2004).

An international comparison clearly reveals the strength of Germany's specialization on R&D-intensive industries, especially high-level technologies, and how this specialization increased up to 2007 (Figure 1). Until the beginning of the financial and economic crises, Germany was the country most clearly specialized on R&D-intensive industries. Only Japan has a similar specialization pattern, whereas the other countries are not specialized on these sectors. Germany also has an especially broadly diversified portfolio in this regard: Seven out of ten R&D-intensive industries have positive RVAs. This is far higher than in the benchmark regions. Even in terms of cutting-edge technologies, Germany is now well above the average of all regions considered.

Japan is the only other nation also specialized in the sub-segment of cutting-edge technologies, as it is strong in office machinery, computers and communication equipment. The US is most heavily specialized in the cutting-

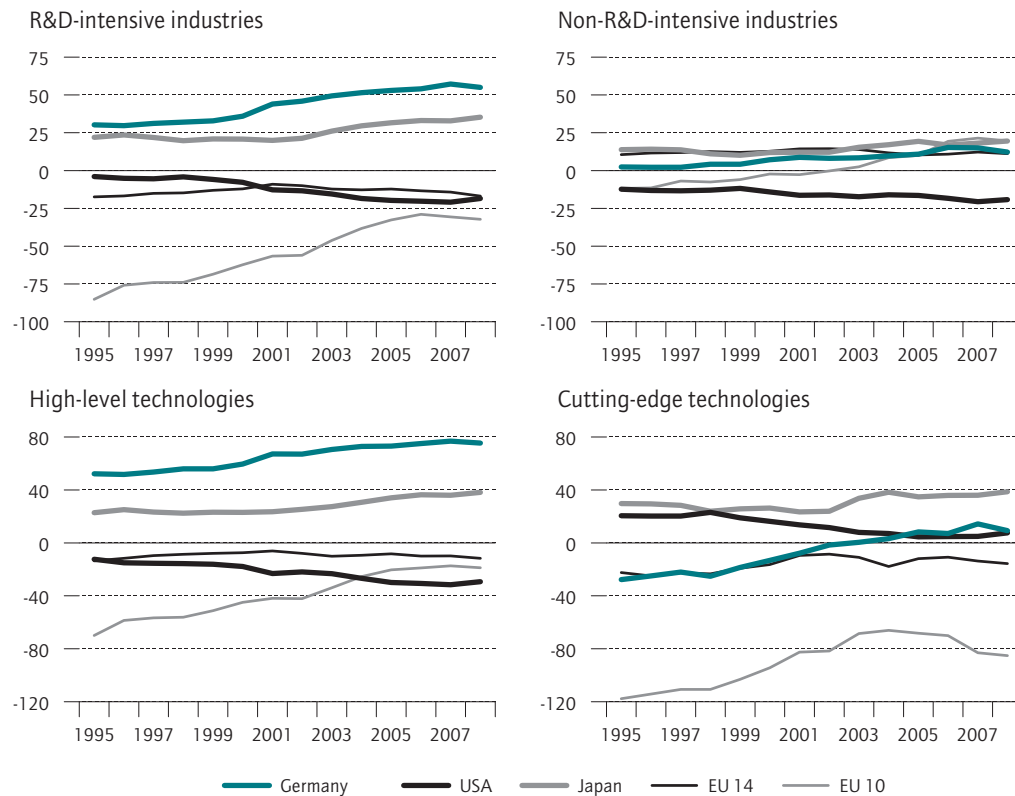
<sup>1</sup> Belitz, H., Clemens, M., Gornig, M., Schiersch, A., Schumacher, D.: Wirtschaftsstrukturen, Produktivität und Außenhandel im internationalen Vergleich. Studien zum deutschen Innovationssystem No. 5/2010. Pub.: Commission of Experts for Research and Innovation, Berlin, February 2010. [www.e-fi.de](http://www.e-fi.de).

<sup>2</sup> Belitz, H., Clemens, M., Gornig, M., Schiersch, A., Schumacher, D.: Wirtschaftsstrukturen, Produktivität und Außenhandel im internationalen Vergleich. Studien zum deutschen Innovationssystem No. 4/2011. Pub.: Commission of Experts for Research and Innovation, Berlin, February 2011. [www.e-fi.de](http://www.e-fi.de).

<sup>3</sup> The RVAs are listed here in natural logarithms multiplied by 100. A value of 0 for all sectors would indicate that the shares are identical. Positive values signify the share is higher than average, while negative values mean it is lower than average. The greater the amount, the greater the (relative) difference in share. Also refer to the RCA in the box within the following article.

Figure 1

**Relative shares of nominal value added by industrial groups in select countries and regions from 1995 to 2008 (RVAs)**



Comments: The relative share of value added or RVA represents the contribution of an industry to the nominal value added in its country in relation to the same contributions in the group of benchmark countries comprising the US, Japan and the EU-25.

Example for reading the table: The R&D-intensive industries in Germany show the highest relative share of value added among the countries considered here. The EU-10 curve in the negative area refers to the less than average but growing contribution from R&D industries. See the Box for definitions of the industrial groups.

US 2008 estimated, Japan: 2007 and 2008 estimated.

Sources: EU KLEMS Datenbasis 11/2009; OECD STAN 2010; calculations and estimates of DIW Berlin.

© DIW Berlin 2011

The cutting-edge technologies are now also making a better than average contribution to value added in Germany.

edge technologie of aircraft and spacecraft. The advantages it had in communication equipment in the middle of the 1990s are now lost, and those in medical and precision instruments have diminished significantly. Germany is meanwhile strongly specialized in medical and precision instruments.

Between 1995 and 2007, German companies gained market shares in nearly every segment of the R&D-intensive industries. In addition, they are very efficient at producing R&D-intensive goods.<sup>4</sup> Indeed the traditionally strong specialization on R&D-intensive industries may bear risks, as proven by the strong decline in pro-

duction at the end of 2008 and in 2009. However, the long-term success of German industry has prompted the US and the UK in particular to call for policy actions to strengthen their own industrial bases again.<sup>5</sup>

### Large production cuts during the crisis ...

In the fall of 2008 the crisis at the financial markets very quickly caused a decrease in demand around the world, which led to recessions in nearly every region. Given the uncertainty in the global markets, capital goods producers suffered the greatest losses. According to our esti-

<sup>4</sup> Belitz, H., Gornig, M., Schiersch, A.: Deutsche Industrie durch forschungsintensive Güter erfolgreich. DIW Berlin Wochenbericht, 9/2010, 2-10.

<sup>5</sup> See for example Ezell, S.J. and Atkinson, R.D.: The Case for a National Manufacturing Strategy, The Information Technology & Innovation Foundation, April 2011.

Box 1

**Classification by sector and region, data basis**

**R&D-intensive industries and knowledge-intensive services**

Research-intensive manufacturing industries are the producers of goods using high-level and cutting-edge technologies, defined as follows:<sup>1</sup>

- The cutting-edge technology category includes goods for which internal R&D expenditures comprise, on an OECD average, more than 7 percent of revenues. This is the case for pharmaceuticals, office machinery and computers, communication equipment, medical and precision instruments, and aircraft and spacecraft.
- The high-level technology category includes goods for which internal R&D expenditures comprise between 2.5 and 7 percent of revenues. This includes chemicals, machinery, electrical machinery and apparatus, motor vehicles, and other transport equipment.

This distinction is based on the R&D intensity and not meant to imply that cutting-edge technology is more "advanced" or "valuable". Goods using cutting-edge technology are more frequently subject to government intervention in the form of subsidies, government contracts, and non-tariff trade barriers. Policies are created to promote them not only with technological goals in mind, but also in pursuit of national goals in areas such as defense, healthcare and the aerospace industry.

<sup>1</sup> Legler, H., Frietsch, R.: Neuabgrenzung der Wissenswirtschaft—forschung-intensive Industrien und wissensintensive Dienstleistungen (NIW/ISI-Listen 2006), Studien zum deutschen Innovationssystem No. 22-2007, German Federal Ministry of Education and Research, Berlin 2007.

**Division of European countries into survey regions**

The "EU-14" are the original EU member states with the exception of Germany: Belgium, Denmark, Finland, France, the United Kingdom, Greece, Ireland, Italy, Luxemburg, the Netherlands, Austria, Spain, Portugal and Sweden.

The "EU-10" are the countries that become members in May 2004: Estonia, Latvia, Lithuania, Malta, Poland, Slovenia, Slovakia, Czech Republic, Hungary and Cyprus. Bulgaria and Romania, which joined the EU in 2007, were not considered in the survey.

**Data basis**

Data compiled by the European research consortium (EU KLEMS) and the OECD (STAN) provide the data basis for an international comparison for the period from 1995 to 2007. The EU KLEMS version of March 2008 provides detailed data, grouped by sector, for every year up to 2005. The values for 2006 and 2007 for Germany, the US and the EU countries have been added, and in some cases estimated, from the more current EU KLEMS version of November 2009 and the OECD STAN data from 2010. The later EU KLEMS provided data for a more limited classification by sector.

Data was further drawn from national reported production indices, price indices, incoming orders, capacity utilization, etc. to calculate the value added and the volumes of work to the present. This data was processed using ARIMAX and naive models to project the value added and volumes of work for each sector up to the present.<sup>2</sup>

<sup>2</sup> For more details, refer to Schiersch, A., Belitz, H., Gornig, M.: Fortschreibung internationaler Wirtschaftsstrukturdaten für FuE-intensive Industrien. Studien zum deutschen Innovationssystem No. 5/2011. Commission of Experts for Research and Innovation, Berlin, February 2011. [www.e-fi.de](http://www.e-fi.de).

mates, the share of industry to total value added fell in every country. In 2010 it was still lower than in 2007, the year before the crisis (Figure 2).

Japan reported the greatest drops: 2.9 percentage points in R&D-intensive and 2.6 percentage points in non-R&D-intensive industries. In Germany, the share of R&D-intensive industries fell by 2.3 percentage points to 11.5 percent between 2007 and 2009. These strongly

export-oriented industries were hit especially hard by the slump in global demand for capital goods. In contrast, the decline in non-R&D-intensive industries turned out to be relatively minor, at 0.3 percentage points.

In 2010 Japan showed the greatest annual growth in the contribution of R&D-intensive industries to value added (2.6 percentage points). Germany came second at 1.1 percentage points.

### ... but only minor reduction in employment

Analyzing production trends is not enough to evaluate the repercussions of the financial and economic crisis on the German economy. Rather, it is also necessary to determine changes in employment and labour productivity. The DIW therefore estimated these time series for different countries and presents the results in this report to an international audience for the first time.

During 2009, the volume of labour in the R&D-intensive industries declined in all of the countries considered in this report (Figure 3). The UK and the US suffered the greatest declines compared to 2007, the year before the crisis. There were strong decreases in the volume of labour in Germany as well. However, these were more moderate than the production cuts would have implied. This development, however, was also different due to the fact that labour market stakeholders (companies, unions and government) took great efforts to prevent a reduction in jobs because of the crisis.

Short-time work was one tool in this respect.<sup>6</sup> In August 2008, shortly before the financial crisis became an economic crisis, about 4,000 companies and 40,000 employees were supported by this instrument. This figure then skyrocketed. It finally peaked in May 2009, when 56,000 companies applied short-time work rules to more than 1.4 million employees.<sup>7</sup> At the same time, the number of employees only shrank by 310,000, in the already seasonal weak period, from August 2008 to January 2009. In April 2009 the unemployment rate for the workforce force was at its zenith during the crisis at 8.6 percent, though this was still below the yearly average from 2005 to 2007. At the same time, the number of hours worked per employee fell by more than 15 percent between Q3 2008 and Q2 2009. This means that the enormous cut in production was not accompanied by an equally extreme reduction in jobs.<sup>8</sup> Rather, many companies held on tight to their employees despite the lack of orders and the strong underutilization of their production capacities, to ensure that they would have the necessary firm specific human capital and capacities to quickly return to pre-crisis production levels.

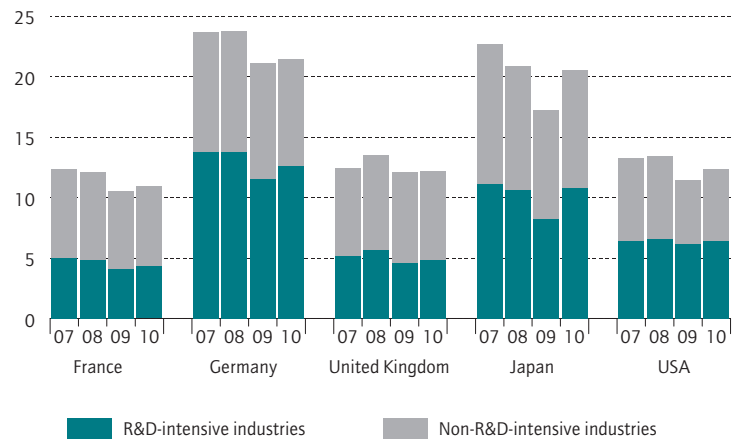
<sup>6</sup> For a detailed presentation of the changes to short-time working rules as a result of the crisis, especially in terms of economic short-time allowances, refer to Mai, C. M.: Der Arbeitsmarkt im Zeichen der Finanz- und Wirtschaftskrise. *Wirtschaft und Statistik*, 3, 2010, 237-247.

<sup>7</sup> The data on short-time working and the following information on employment figures and hours worked was drawn from the Genesis database run by the Federal Statistical Office (Statistisches Bundesamt), [www.genesis.destatis.de](http://www.genesis.destatis.de)

<sup>8</sup> Another step used heavily to maintain employment during the financial and economic crises was the work-off of overtime account balances. Zapf, I., Brehmer, W.: Working time accounts have proven to be of value. IAB Brief Report, 22/2010.

Figure 2

#### Contribution of R&D-intensive and non-R&D-intensive industries to national value added from 2007 to 2010



Sources: EU KLEMS Datenbasis 11/2009; calculations and estimates of DIW Berlin.

© DIW Berlin 2011

The R&D-intensive sectors in Germany and Japan plummeted but then recovered quickly from the crisis.

Other actions also assisted these efforts, such as additional state subsidies to companies for research, development and innovation.<sup>9</sup>

#### Only short-term decline in labour productivity

These policies of German firms during the crisis, caused a decrease in labour productivity in 2009 which had never been seen before. Every R&D-intensive industry in Germany was affected (Figure 3). Labour productivity in machinery declined particularly drastically, but this industry also reported the harshest production cuts. However, in 2010 labour productivity in the R&D-intensive industries in Germany was nearly back to the pre-crisis level. The strategy pursued during the crisis to secure jobs thus had no long-term negative impact on labour productivity as a measure of production efficiency.<sup>10</sup>

Labour productivity in the UK and the US, which traditionally follow more conservative labour market policies,

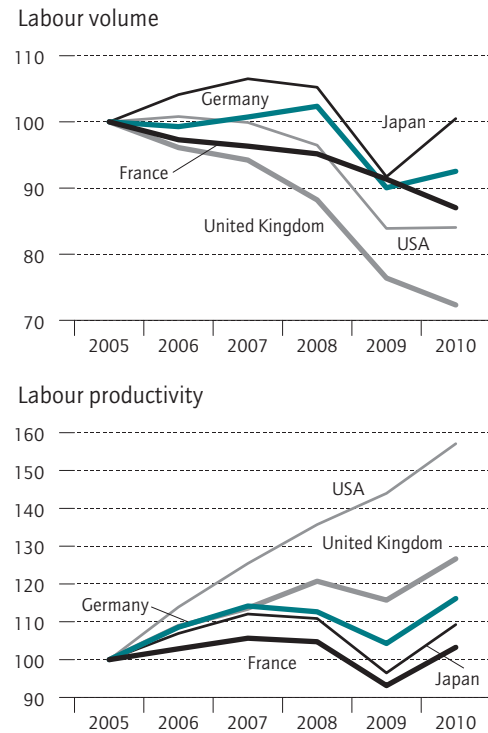
<sup>9</sup> According to the Center for European Economic Research (ZEW), innovation expenditure did not shrink as much as production during the 2009 year of crisis, meaning that the intensity of innovation even increased from 2.72 to 2.74 percent. The R&D-intensive industries were especially persistent, increasing their intensity of innovation from 7.7 to 8.4 percent. Rammer C. et al. (2011): Innovationserhebung für Deutschland 2010–Mit Schwung aus der Krise. Mannheim, January 2011.

<sup>10</sup> Based on the available data, no comment can be made on the adjustments to and efficiency of the capital input.

Figure 3

### Labour volume and labour productivity in the R&D-intensive industries

Index 2005 = 100



Sources: EU KLEMS Datenbasis 11/2009; calculations and estimates of DIW Berlin.

© DIW Berlin 2011

The labour productivity of the R&D-intensive industries is greater now than before the crisis.

showed quite different trends.<sup>11</sup> The decline in the volume of labour in the R&D-intensive sectors of both countries was so harsh that in some cases it overcompensated the decrease in value added. In the UK, labour productivity in the R&D-intensive industries diminished in 2009, but this was mainly due to the temporary productivity losses in machinery and electrical machinery. In contrast, labour productivity increased further in the other R&D-intensive industries.

This trend was even more pronounced in the US manufacturing industry. The companies in the US reacted to the crisis by reducing their workforce, often more than their production decreased. Except for machinery, this meant that labour productivity in the R&D-intensive sec-

tors also rose during 2009. Therefore, measured by labour productivity, the efficiency of the US R&D-intensive industries even improved as a result of the crisis.

The development of labour volume and labour productivity in the two Anglo-Saxon countries is characterised by the policy of "hire and fire". Nonetheless, the greater productivity in these two countries did not translate into relatively higher market shares for the R&D-intensive industries. Rather, Germany held onto its lead over the UK and the US.

### Conclusions

The R&D-intensive and heavily export-oriented German manufacturing industry has passed its trial by fire during the global economic crisis and at least held onto its leading international competitive position. This success is due principally to the fact that companies were mostly able to maintain their human capital throughout the crisis because of the concerted action of company management, unions and politicians. In this regard, however, there is always a risk of preserving industry structures that will no longer be competitive in the long term.

To be able to react appropriately and flexibly to future shocks to global demand, the actors need instruments that allow them to distinguish between temporary decreases in demand and long-term structural changes. This could prevent existing competitive advantages from being recklessly jeopardized and, at the same time help reduce the subsidies needed to preserve obsolete structures. This is why we see the need for a scientifically founded, international industrial monitoring system which gives politicians early indication of upcoming structural shocks triggered by external factors.

Dr. Heike Belitz is a researcher in the Innovation, Industry, Services department | hbelitz@diw.de

Prof. Martin Gornig is provisional manager of the Innovation, Industry, Services department | mgornig@diw.de

Alexander Schiersch is a researcher in the Innovation, Industry, Services department | aschiersch@diw.de

JEL Classification: O14, O40, O57

Keywords: Industrial specialization, international trade, manufacturing industries

Article first published as "Wertschöpfung und Produktivität wieder stark gestiegen", in: DIW Wochenbericht Nr. 17/2011.

<sup>11</sup> For the US also Schatz, P., Spitznagel, E.: Macroeconomic dynamism of labour markets: a comparison of internal and external flexibilities in the USA and in Germany. WSI-Mitteilungen, 63 (12), 2010, 626–635.



DIW Berlin – Deutsches Institut  
für Wirtschaftsforschung e.V.  
Mohrenstraße 58, 10117 Berlin  
T +49 30 897 89 -0  
F +49 30 897 89 -200

Volume 1, No 2  
5 August, 2011

#### Publishers

Prof. Dr. Pio Baake  
Prof. Dr. Tilman Brück  
Prof. Dr. Christian Dreger  
Dr. Ferdinand Fichtner  
PD Dr. Joachim R. Frick  
Prof. Dr. Martin Gornig  
Prof. Dr. Peter Haan  
Prof. Dr. Claudia Kemfert  
Karsten Neuhoﬀ, Ph. D.  
Prof. Dr. Jürgen Schupp  
Prof. Dr. C. Katharina Spieß  
Prof. Dr. Gert G. Wagner  
Prof. Georg Weizsäcker, Ph. D.

#### Editors in chief

Dr. Kurt Geppert  
Sabine Fiedler

#### Editorial staff

Renate Bogdanovic  
Dr. Frauke Braun  
PD Dr. Elke Holst  
WolfPeter Schill

#### Editorial manager

Alfred Gutzler

#### Press office

Renate Bogdanovic  
Tel. +49-30-89789-249  
Sabine Fiedler  
Tel. +49-30-89789-252  
presse@diw.de

#### Sales and distribution

DIW Berlin

Reprint and further distribution—including extracts—with complete reference and consignment of a specimen copy to DIW Berlin's Communications Department (kundenservice@diw.berlin) only.

Printed on 100% recycled paper.